

## **REMARKS**

This is meant to be a complete response to the Office Action mailed July 10, 2009 in which claims 1-27 are rejected. Applicants have amended independent claims 1 and 19, as well as claims 2-3, 8-11, 13-14, 16, 18, 20, 24, and 27 which depend therefrom. Claims 12, 17, and 26 have been canceled herein from the pending application. Claims 1-11, 13-16, 18-25, and 27 remain pending in this application.

## **CLAIM AMENDMENTS**

Applicants respectfully submit that the amendments to claims 1, 2-3, 8-11, 13-14, 16, 18, 19, 20, 24, and 27 are for clarification purposes only and do not introduce any new matter into the present application. Specifically, independent claims 1 and 19 have been amended to incorporate the limitations previously set forth in now-cancelled dependent claims 17 and 26, respectively. These limitations specify that the filter cake is broken into pieces having average diameters of less than about five centimeters. Dependent claims 2-3, 8-11, 13-14, 16, 18, 20, 24, and 27 have been amended to show proper dependence and to provide complete accuracy with respect to antecedent basis. Support for these amendments can be found in paragraphs [0015]-[0017], as well as in the figures, for example.

**APPLICANTS' RESPONSE TO THE REJECTION OF CLAIMS 1-27**  
**UNDER 35 U.S.C. § 103(a)**

In the Office Action mailed July 10, 2009, the Examiner rejected claims 1-27 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 5,779,761 issued to Armstrong et al. (hereinafter referred to as "Armstrong") in view of U.S. Patent 2,205,854 issued to Kroll (hereinafter referred to as "Kroll"). For the reasons set forth hereinbelow, Applicants respectfully submit that Rosenberg fails to teach or suggest each and every limitation recited in independent claims 1 and 19, as amended.

Applicants' independent claim 1, as amended, is directed to a method of separating metal particulates from a slurry consisting essentially of liquid reducing metal, metal particulates, and salt particulates. The method includes four steps, namely: (1) filtering the slurry to form a filter cake of metal and salt particulates, wherein the filter cake further includes a residual amount of liquid reducing metal; (2) breaking the filter cake into pieces having average diameters of less than about five centimeters; (3) removing at least a portion of the residual liquid reducing metal from the broken filter cake; and (4) separating the metal and salt particulates. Independent claim 19, as amended, is identical to claim 1 with the exception of an additional step following the separation of the metal particulates that includes sizing the metal particulates prior to washing the metal

particulates with water to prevent unacceptable explosions of the metal particulates upon contacting the metal particulate with water.

The method recited in independent claim 1 (the broadest independent claim), as amended, while related to the production method of elemental materials described in Armstrong, recites separation improvements to the Armstrong Process that unexpectedly result in distinct advantages not contemplated by Armstrong (or Kroll).

Armstrong describes a method of producing a non-metal, metal, or alloy thereof from a halide or mixtures thereof. The halide or mixture of halides is contacted with a stream of liquid alkali, alkaline earth metal, or mixtures thereof in a sufficient quantity to convert the halide to the non-metal, metal, or alloy. (Armstrong, Abstract). For example, Armstrong specifically discloses the injection of titanium chloride vapor into a flowing sodium stream that results in a reduction reaction that produces molten reaction products of titanium and sodium chloride. (Armstrong, Col. 3, Lines 43-51). The reaction products are then removed from the sodium stream by separators, such as cyclones or particulate filters, after which the titanium is separated from the sodium chloride. (Armstrong, Col. 3, Lines 65-67 and Col. 4, Lines 1-39). There is nothing in Armstrong to teach, or even suggest, the formation of a filter cake, and, as the Examiner notes, Armstrong explicitly fails to "disclose the steps of breaking the

cake and then removing liquid metal from the broken cake, and thereafter separating the metal and salt particulates." (Office Action dated July 10, 2009, hereinafter referred to as "the Office Action," page 3).

As stated by the Examiner, Armstrong does acknowledge the Kroll Process, however this acknowledgement is limited to the deficiencies associated with the Kroll Process and the advantages realized by the Armstrong Process (i.e., savings in capital, processing times, and environmental impact). (Armstrong, Col. 1, Line 59-Col.2, Line 26).

The deficiencies in Armstrong are not remedied by the combined teachings of Kroll. Kroll discloses a method for forming a metal in which a reaction is initiated by dropping a metal chloride onto the surface of molten magnesium. (Kroll, Col. 4, Lines 27-30). The fused titanium mass is then processed to produce a titanium powder or compact. The processing of the fused reaction mass to form a commercially valuable product by the Kroll Process is labor intensive and costly. As stated in Col. 4, Line 63 to Col. 5, Line 16 of Kroll:

At the end of the reaction the crucible is filled with a mixture of fused alkaline earth metal chloride and compact titanium in large lumps. According to the invention ***the crucible content is bored***, for instance on the lathe, with the aid of high-speed steel, which is easily possible owing to the slight hardness of titanium (about 280 Brinells). In this case the salts act as a support and the boring can be effected up to

a slight distance from the molybdenum lining. The advantage of this method consists in that titanium chips are obtained which have become brittle by the cold coring and therefore may easily be pulverized. The mixture removed by boring is subsequently treated with water which removes  $\text{MgCl}_2$ , and then with diluted hydrochloric acid. In the meantime the pulverization is effected as far as possible in a wet state. The chips are ground according to the invention in a steel mortar or in a steel ball mill. Porcelain parts should not be employed when pulverizing in order to prevent the mixture from absorbing from ground-off porcelain particles. The pulverization is effected to such an extent as to ***permit the passage of the particles through a screen*** of about 150 meshes/cm<sup>2</sup> and thereafter the particles are treated in a weak solution of hydrochloric acid by the application of heat. (emphasis added).

As evidenced above, the fused titanium mass produced by the Kroll Process requires extensive processing, including: (1) boring the titanium mass from the reaction vessel's lining; (2) pulverizing the chips obtained from the bored mass to a specified size; (3) passing the pulverized titanium mass through a sifting screen for further processing of the sifted titanium-containing powder.

There is nothing in Kroll to teach or suggest filtering a slurry to form a filter cake of metal and salt particulates, wherein the filter cake further includes a residual amount of liquid reducing metal, as recited by Applicants' claim 1 (and 19), as amended. Rather, the pulverized titanium mass is simply passed through (rather than collected on to form a filter cake) a sifting screen for further processing. Moreover, Kroll fails to disclose breaking the filter cake and removing at least a

portion of the residual liquid reducing metal from the broken filter cake, as recited in Applicants' claim 1 (and 19), as amended.

As previously mentioned, independent claims 1 and 19 have been amended herein to include the limitations previously set forth in now-cancelled dependent claims 17 (now recited in independent claim 1) and 26 (now recited in independent claim 19). These limitations specify that the filter cake is broken ***into pieces having average diameters of less than about five centimeters***. The Examiner acknowledges that "neither Armstrong et al. or [Kroll] discloses that the cake is broken into pieces having diameters up to about five centimeters..." (Office Action, Page 6). The Examiner states, however, that "without showing unexpected results, the claimed diameter cannot be considered critical." (Office Action, Page 6). For the reasons stated hereinbelow, Applicants respectfully submit that breaking the filter into pieces having average diameters of less than about five centimeters produces unexpected results and advantages previously unrealized by Armstrong and Kroll.

The present application's specification clearly describes the unexpected and distinct advantages of breaking the filter cake, and, more specifically, breaking the filter cake into pieces having an average diameters of less than about five centimeters. As stated in paragraphs [0015]-[0017] of the present application:

***[I]t has been found that breaking the filter cake drastically reduces the distillation times and rates for the distillation of liquid metal, such as sodium.*** Using a breaker bar or some other mechanical means such as moving fingers or a mixer has significantly reduced the first portion of the vacuum distill from 40,000-50,000 seconds (11-14 hours) to 20,000 to 30,000 (between about 6 to 8 hours)...

By using either one of the methods or a combination of breaking the filter cake combined with an inert gas sweep, ***the distillation times can decreased from about (22 or 28) hours to about (9 to 11) hours.*** This is of significant importance in the design of plants by simplifying designs, reducing collection tanks, valves, piping, and other associated equipment. After vacuum distillation is apparently complete, any remaining trapped reductant metal (sodium) becomes impractical to remove. While it seems obvious to introduce the filter cake into water to wash the residual salt (NaCl) from the titanium powder, the problem exists of trapped reductant metal (sodium) in the filter cake which when combined with water could produce a significant explosion. It is a fact that the mixture of sodium liquid and water will provide an explosion having energy greater than the equivalent amount of TNT.

It has been found in the production of Ti by the subsurface reduction of  $\text{TiCl}_4$  by Na that crumbling the filter cake into small quantities, ***such as less than about five centimeters in diameter and preferably in the range of from about two to about five centimeters in diameter,*** during or subsequent to the distillation of sodium apparently makes particles or clumps small enough that any trapped Na is manageable without significant damage to equipment or harm to personnel, if proper care is taken in equipment design and with appropriate safety precautions. After distillation, the filter cake is friable and easily crumbled. ***To the extent that large quantities of crumbled filter cake can be water washed without fear of explosion***

***significantly reduces the distillation times required in the production of the various elemental material and alloys described in the above-referenced patents [i.e., Armstrong and/or Kroll], particularly where sodium or other alkaline metal is used as a reductant.***  
(emphasis added).

It is clear from the above that breaking the filter cake into pieces having average diameters less than about five centimeters, as recited in claims 1 and 19, as amended, provides for significant improvements and unexpected advantages over the methods disclosed in Armstrong and Kroll. These advantages, at least, include: (1) a decrease in the distillation times and rates for the distillation of liquid metal from the broken filter cake; (2) a reduction in the likelihood of spontaneous explosions caused by entrapped reductant metal<sup>1</sup> present within the filter cake; and (3) a decrease in the costs associated with damage and harm to personnel and equipment.

For the reasons set forth above concerning the teachings of Armstrong and Kroll, it is respectfully submitted that Armstrong and Kroll, whether viewed singularly or in combination, does not disclose,

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<sup>1</sup> Applicants agree with the Examiner that Kroll describes the use of magnesium as the reductant metal, rather than sodium. Applicants, however, disagree with the Examiner's statement on page 4 of the Office Action that "[Kroll] also uses magnesium instead of sodium, ***which does not produce an explosion upon contact with water.***" (emphasis added). Applicants respectfully submit that magnesium, when finely powdered, is highly reactive with water and can spontaneously ignite or explode upon contact with water. This notion is supported by the *Material Safety Data Sheet* for magnesium attached hereto as Exhibit A. Accordingly, the unexpected advantages realized by breaking the filter cake into pieces having average diameters less than about five centimeters provides for significant and unexpected improvements over the titanium production process described in Kroll.



teach, or suggest the separation method recited in Applicants' independent claims 1 and 19, as amended.

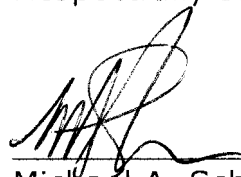
Accordingly, Applicants request the Examiner to reconsider and withdraw the rejection of claims 1-27 and pass the currently pending claims to an expedient allowance.

### **CONCLUSION**

This is meant to be a complete response to the Office Action mailed July 10, 2009. In view of the above arguments, Applicants respectfully submit that all pending claims are now in a condition for allowance and request issuance of a Notice of Allowance thereof.

Should the Examiner have any outstanding issues regarding this application, Applicants' undersigned attorney would welcome the opportunity to discuss such issues with the Examiner.

Respectfully submitted,



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